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CLIMATIC CHAMBER TESTING (AIRCRAFT, ENGINES ARMAMENT AND AVIONI--ETC(U)
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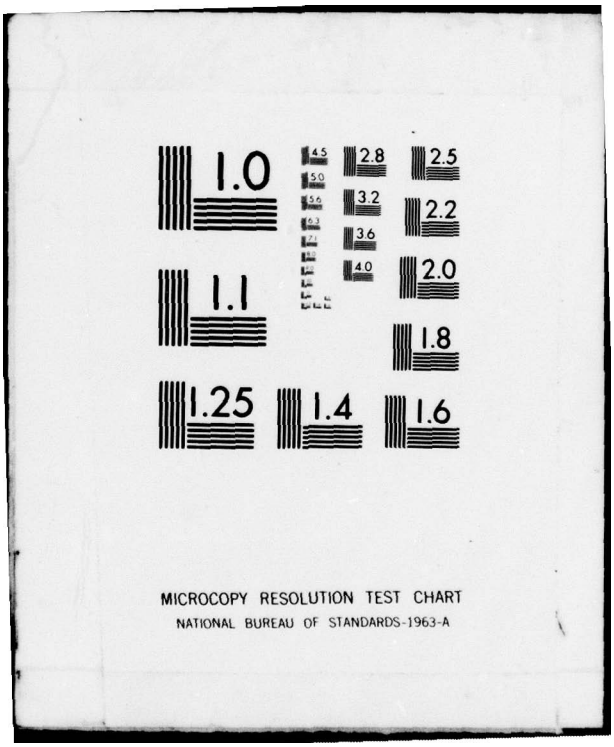
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20. ABSTRACT *(Continue on reverse side if necessary and identify by block number)*
This document provides information, guidance and methodology for planning and conducting an environmental climatic chamber developmental test of aviation materiel. Environmental climatic chamber developmental testing in general, determines the degree to which aviation materiel meets the developmental requirements of the US Army Materiel Needs (MN) documents, when subjected to the environmental conditions developed in the climatic chamber.

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US ARMY TEST AND EVALUATION COMMAND
TEST OPERATIONS PROCEDURES

DRSTE-RP-702-106
*Test Operations Procedures 7-3-521 31 August 1979
AD No.

CLIMATIC CHAMBER TESTING
(AIRCRAFT, ENGINES, ARMAMENT AND AVIONICS)

1. SCOPE. This document establishes procedures and test methods to evaluate Army aviation materiel's compatibility with induced environments peculiar to military operations. In particular, it provides environmental test methods to evaluate performance of equipment under the range of climatic conditions set forth in the Materiel Needs documents (LR, LOA, ROC), or other governing documents in an economical manner, with reproducible test results.

2. FACILITIES, INSTRUMENTATION AND SUPPORT REQUIREMENTS. Climatic chamber testing of Army aviation materiel will normally be performed with a very specific test article configuration, under very specific environmental conditions, and in accordance with specified Army maintenance

*This TOP supersedes MTP 7-3-521, 1 November 1971

or operational scenarios as defined in the Test Design Plan. Facilities, instrumentation and support equipment requirements are usually defined in the Coordinated Test Program (CTP), Test Design Plan and/or Maintenance Support Plan (MSP); however, if this information is not available, the following facility characteristics, instrumentation and support equipment should be addressed as a minimum to support the test:

2.1 Facilities.

CHARACTERISTICS	MINIMUM REQUIREMENTS
Climatic Chamber	Sufficient size to accommodate the test item and associated support fixtures.
Office space	Sufficient to accommodate the test team.
Data reduction	Calculator or computer based on estimated quantity of data to be processed.

2.2 Instrumentation Requirements.

Mechanical and electrical performance measuring equipment	Temperature, pressure, forces, flow rates, time.
Data recorder	Analog, digital.

2.3 Support Requirements.

2.3.1 Equipment.

Photographic equipment	Camera (B&W).
Aircraft and avionics maintenance support equipment	As required.

CHARACTERISTICS	MINIMUM REQUIREMENTS
Equipment required by referenced TOP's	As required.
Aircraft tie down equipment	As required.
Aircraft logistics equipment	Tug, tow bar.
Aircraft support equipment	APU, Pre-heaters, Hydraulic mule, etc.
Environment protection equipment	As required.

2.3.2 Personnel.

Pilot-Operator	One.
Aircraft Maintenance	As required.
Avionics Maintenance	As required.
Data Collection and Processing	As required.

2.4 References.

a. Army Regulation 385-16, System Safety.

b. Army Regulation 750-1, w/TECOM Supplement 1, Army Materiel Maintenance Concepts and Policies.

c. Army Regulation 750-6, Maintenance of Supplies and Equipment: Maintenance Support Planning.

d. AMC Regulation 70-8, w/ TECOM Supplement 1, DARCOM Value Engineering Program.

e. AMC Regulation 385-12, w/TECOM Supplement 1, Life Cycle Verification of Materiel Safety.

f. AMC Regulation 700-38, w/TECOM Supplement 1 and USAADTA Supplement 1, Test and Evaluation -- Incidents Disclosed During Materiel Testing.

g. TECOM Regulation 70-24, Research and Development: Documenting Test Plans and Reports.

h. TECOM Regulation 108-2, Photographic Coverage. (As implemented by USAADTA Memo 108-1).

i. MIL-STD-210, Climatic Extremes for Military Equipment.

j. MIL-STD-810, Environmental Test Methods.

k. MIL-STD-882, System Safety Program Requirements.

l. MIL-E-5272, Environmental Testing, Aeronautical and Associated Equipment; Specifications for.

m. TOP 1-2-609, Instructional Material Adequacy Guide and Evaluation Standard (IMAGES).

n. TOP 1-2-610, Human Factors Engineering.

o. TOP 7-3-500, Physical Characteristics (Aviation Materiel).

p. TOP 7-3-501, Personnel Training.

q. TOP 7-3-502, Installation Characteristics.

r. TOP 7-3-503, Arrival Inspection/Pre-Operational Inspection (Aviation Materiel).

s. TOP 7-3-506, Safety (Aviation Materiel).

t. TOP 7-3-507, Maintenance (Maintainability/Availability).

u. TOP 7-3-508, Reliability.

v. TOP 7-3-509, Compatibility with Related Equipment.

w. TOP 7-3-519, Photographic Coverage.

x. TOP 7-3-530, Vulnerability and Security (Aviation Materiel).

y. Materiel Needs documents (LR, LOA, ROC).

3. PREPARATION FOR TEST. This section provides guidance for planning the development climatic chamber test. The planning phase should consummate with a detailed test plan. The test plan should establish the test methodology and provide the procedures for gathering and reducing data to accommodate each developmental test objective/criteria. The test plan should also identify all facility, equipment and support requirements including any specialized training requirements. The following test planning steps should be followed to insure a complete, thorough and cost effective test.

3.1 Review. Review all pertinent data relative to the materiel development test.

a. Materiel Needs documents (LR, LOA, ROC).

b. Test Design Plan.

c. Applicable material available from the developer.

d. Pertinent reports on previous tests of like equipment.

e. Any other applicable sources of information (AR, TOPs, TM, etc.).

3.2 Test Objectives. Establish the test objectives. The test objectives should be available in the Test Design Plan; however, if this information is not

available, the test agency should coordinate with TECOM HQ and the materiel proponent when establishing objectives or review the Materiel Needs documents for developmental criteria and consider the following subtest objectives as a minimum:

a. Initial Inspection. Determine the condition and completeness of the test item upon receipt at the climatic chamber testing facility in accordance with TOP 7-3-503.[1]

b. Installation Characteristics. Determine the installation/removal characteristics of the test item under appropriate climatic conditions in accordance with TOP 7-3-502.[2]

c. Compatibility. Determine the compatibility of the test item to related equipment during all applicable phases of operation and applicable climatic test conditions in compliance with TOP 7-3-509.[3]

d. Operational Performance. Determine the adequacy and suitability of the developmental test item to perform its intended function in the controlled environment and designated operational modes. Follow the testing procedures as presented in paragraph 5, Performance Test, this TOP. Pay special attention to the human factors environmental considerations.

e. Reliability, Availability and Maintainability (RAM). Evaluate the RAM characteristics of the developmental test item under the controlled environmental conditions and in accordance with TOP 7-3-507[4] and TOP 7-3-508.[5]

f. Technical Manuals. Determine the adequacy of the technical manuals to maintain and operate the test item in the induced test environment and in accordance with TOP 1-2-609.[6]

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1. TOP 7-3-503, Arrival Inspection/Pre-Operational Inspection (Aviation Materiel).
2. TOP 7-3-502, Installation Characteristics.
3. TOP 7-3-509, Compatibility with Related Equipment.
4. TOP 7-3-507, Maintenance (Maintainability/Availability).
5. TOP 7-3-508, Reliability.
6. TOP 1-2-609, Instructional Material Adequacy Guide and Evaluation Standard (IMAGES).

g. Personnel Training Requirements. Determine the scope of the pre-developmental test and field training required to operate and maintain the test item and support equipment under the controlled environmental condition in accordance with TOP 7-3-501.[7]

h. Human Factors. Determine if testing of the item is in accordance with TOP 1-2-610[8] and that transport, erection, operation, and maintenance meet human factors engineering requirements under the controlled environmental condition.

i. Safety. Identify and evaluate any hazardous characteristics of the test item, maintenance and operation, under the controlled environmental condition (see TOP 7-3-506).[9]

3.3 Schedule. Prepare a detailed test timeline depicting each test associated event which must occur to insure availability of required support equipment, facilities, logistics and personnel to accomplish a comprehensive and cost effective climatic chamber test. An adequate timeline will show sufficient time periods allotted to accomplish each test objective insuring that an adequate amount of test data are taken to provide projected statistical confidences when the data is reduced. Scheduling of the following items should be addressed as a minimum.

a. Facility. Schedule the applicable facility requirements presented in Section 2.1. Insure that adequate time is available to accommodate environmental soak periods at each test environment.

b. Equipment and Support. Schedule the applicable instrumentation, equipment and support requirements presented in Sections 2.2 and 2.3.

c. Logistics. Schedule logistics requirements including ground handling equipment, administrative transportation of both personnel and equipment, aircraft fueling and servicing accommodations.

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7. TOP 7-3-501, Personnel Training.
8. TOP 1-2-610, Human Factors Engineering.
9. TOP 7-3-506, Safety.

3.4 Plan of Test. Develop a detailed test plan in accordance with TECOM Regulation 70-24,[10] and in compliance with the TOP's program. This test plan will provide the test procedures to be followed and the test data collection requirements to satisfy the test objectives/criteria.

3.5 Safety. Review the test item sponsor's safety statement (AMC Regualtion 385-12 w/TECOM Supplement 1, Life Cycle Verification of Material Safety)[11] and develop adequate safety and health measures for test participants and for the protection of equipment. Take appropriate steps (training, safety checklist, posters, etc.) to insure that the safety measures are observed throughout the test (see TOP 7-3-506).[12]

3.6 Environmental Impact. Determine if there are any environmental considerations. If environmental hazards exist, develop procedures or outline precautions to be observed to protect the environment. See Construction Engineering Research Laboratory (CERL) Technical Report E-59.[13]

3.7 Human Factors Engineering. Insure good human factors engineering practices are planned into the test and conducted by qualified personnel in the induced test environment. The major considerations should be in the areas of test personnel safety, physiological functions and test conduct efficiency. See TOP 1-2-610,[14] dated 20 December 1977.

3.8 Security. Security safeguards for the United States Government and for the security of the proprietary rights of the test materiel developer must be considered early in the test planning stage. The following steps must be taken:

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10. TECOM Regulation 70-24, Research and Development: Documenting Test Plans and Reports.
11. AMC Regulation 385-12, w/TECOM Supplement 1, Life Cycle Verification of Materiel Safety.
12. TOP 7-3-506, Safety (Aviation Materiel).
13. CERL Technical Report E-59: Handbook for Environmental Impact Analysis.
14. TOP 1-2-610, Human Factors Engineering.

a. Consult the primary test agency security representative for security guidance. Coordinate with security personnel of other test support agencies and industry as appropriate.

b. Take appropriate security measures throughout the test to safeguard intra-industry proprietory and classified material and to safeguard the security of government property.

c. See TOP 7-3-530.[15]

4. TEST CONTROLS. The developmental climatic chamber test will be conducted and test data will be recorded in strict compliance with the Test Design Plan. If specific directions are not available, the following guidelines will prevail:

a. Measurement units will be reported in the universal metric and English system.

b. Numerical observations will be rounded off to the nearest hundredth.

c. Time will be reported to the nearest hundredth of an hour.

d. Physical characteristics will be accomplished and recorded in compliance with TOP 7-3-500.[16]

e. Instrumentation and equipment will be properly calibrated and have a current calibration certificate.

f. All tests will be conducted and data collected in compliance with prescribed and/or standard procedures and when deviations are required.

g. All data will be recorded and processed in a timely fashion.

h. Only properly trained and qualified personnel will participate in the conduct of the test.

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15. TOP 7-3-530, Vulnerability and Security (Aviation Materiel).
16. TOP 7-3-500, Physical Characteristics (Aviation Materiel).

i. Each test run will be conducted under documented conditions, such that the test results could be duplicated or compared.

j. The detailed test plan will be followed; deviations from same must be approved and will be documented.

5. PERFORMANCE TEST. The conduct of the development test shall be performed in compliance with the Test Design Plan reflected through the detailed test plan. However, if specific guidance is not available in the Test Design Plan, the test plan will reflect the following criteria and methodology to conduct the climatic chamber test of the developmental test item.

5.1 Test Facility.

5.1.1 Volume. The volume of the test chamber shall be of sufficient size so that the envelope of the test item will not interfere with the operation of the test chamber such that a test item is provided a uniform and controlled environmental condition not subject to interference from non-test activity or environmental conditions. Multiple test items may be tested simultaneously in keeping with the restrictions and implied intention of this paragraph. The volume of the test chamber must accommodate the test item in a manner which will simulate service usage, unless otherwise specified.

5.1.2 Environment Medium. The heating or cooling environment source of the test facility shall be so located and distributed in the test chamber so that radiant heat from a heat source or direct air from a heating or cooling source will not fall directly on the test item, except where application of these conditions is a requirement of test.

5.1.3 Environment Control. The test chamber environmental control system must be capable of effecting and maintaining the specified test environmental condition at the test bulk throughout the test.

5.2 Installation and Maintenance of Test Item in the Test Facility.

5.2.1 Installation Configuration. Unless otherwise specified, the test item shall be installed in the test facility in a manner which will simulate service usage.

5.2.2 Configuration Control. Configuration control will be strictly maintained for each test run. Plugs, covers, inspection plates, etc., will be installed in accordance with operation or service usage. Instrumentation connections or attachments will be made as required; however, interference with the normal operational or servicing characteristics will be held to a minimum. If applicable, an assessment of the test performance characteristics, due to test item or instrumentation installation, will be made.

5.2.3 Test Installation Verification. The test item shall be installed and operated at standard ambient conditions, if applicable, to verify test item integrity due to storage, handling and/or installation techniques.

5.3 Baseline Performance. Unless otherwise stated in the test directive or Test Design Plan, baseline test runs will be performed at the beginning and end of the climatic chamber test runs. These data will be used to verify test item operational and structural integrity. Standard ambient conditions in accordance with MIL-STD-810, Environmental Test Methods,[17] are:

Temperature	$23^{\circ} \pm 1.4^{\circ}C$ ($73^{\circ} \pm 2.5^{\circ}$ F)
Relative Humidity	50 percent $\pm$ 5 percent
Atmospheric Pressure	$725 \begin{smallmatrix} +50mm \\ -75mm \end{smallmatrix}$ Hg ($28.5 \pm \begin{smallmatrix} 2.0 \\ 3.0 \end{smallmatrix}$ in Hg)

5.4 Stabilization of Test Temperature.

5.4.1 Operating. Unless otherwise specified, temperature stabilization will have been attained when the temperature of the part of the test item considered to have the longest thermal lag is changing no more than $2.0^{\circ}C$ (3.6° F) per hour.

5.4.2 Nonoperating. Unless otherwise specified, temperature stabilization will have been attained when the temperature of the part of the test item

17. MIL-STD-810, Environmental Test Methods.

considered to have the longest thermal lag reaches a temperature within 2.0°C (3.6° F) of the prescribed temperature, except that any critical component (e.g., battery electrolyte or propellant for engine starting test) will be within 1°C (1.8° F).

5.4.3 Temperature Change. When changing temperature, between test runs, the temperature of the chamber air may be adjusted up to 5°C (9° F) beyond the desired end point for a period of time of up to one hour to reduce stabilization time, provided that the stabilization requirements of the test specifications are ultimately attained relative to the specified end point temperature, and provided the extended chamber temperatures will not cause damage to the test item.

5.5 Operational Performance.

5.5.1 Method. In general, the operational procedures for climatic chamber testing can be generalized in a few steps as follows:

a. Position and secure the test item as required into the test cell.

b. Consider all test item operational restraints.

c. Verify instrumentation is operational.

d. Adjust the climatic facility control to provide the required climatic condition for the test run.

e. Stabilize the required climatic condition and climatically soak the test item as required.

f. Perform the required operational procedures including preflight, inflight and postflight task within previously established limits.

g. Record any degradations to normal operations which could be attributed to the simulated climatic condition.

h. Repeat the preceding procedures for each climatic condition as required.

Intricate details of how each step is performed vary in accordance with the test objective. Test procedures and emphasis should be tailored to reflect the aviation materiel developmental criteria and to satisfy the materiel developmental test objectives. These criteria and test objectives must be clearly determined prior to climatic chamber test planning. These requirements are normally available in the Materiel Needs documents and presented in the Test Design Plan. A "cookbook" of some nineteen environmental test procedures are presented in MIL-STD-810[18] and, in many cases can be used as is or modified to accommodate the majority of the test requirements. Appendix C presents three examples of the nineteen test methods presented in the above MIL-STD: Method 501.1, High Temperature; Method 502.1, Low Temperature; and Method 503.1, Temperature Shock. Test personnel responsible for conducting simulated environmental tests should become familiar with the cited MIL-STD to use as a guide in planning a simulated environmental test and to insure compliance of planned test methods with the established standard procedures.

5.5.2 Data Required. As a minimum the following data will be recorded during conduct of the test.

5.5.2.1 Test Initiation Data.

a. Test item nomenclature, serial number, model number and other pertinent test item identification data.

b. Climatic test facility identification data.

c. Test equipment nomenclature, serial number, model number and other pertinent test equipment identification data.

d. Accuracy tolerance and calibration requirements data.

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18. Ibid.

e. Test item condition, electrical, structural, mechanical prior to test start.

f. Personnel qualification and training assessment to conduct the test.

g. Installation assessment, test conduct flexibility and accessibility for operation and maintenance.

5.5.2.2 Performance Data.

a. Operators', observers', and other test personnel's recorded observations, questionnaires, and other narrative data.

b. Event time line including all circumstances and parameter changes leading up to a test anomaly.

c. Photographs; still and movie.

d. Plots, graphs of pertinent correlated test data. Identify test phase, data source, time interval, etc.

e. Test facility environmental parameters such as temperature, pressure, humidity, precipitation and wind conditions, as applicable.

f. Test item performance parameters such as temperature, pressure, velocities (RPM), torque, forces, time, etc.

5.5.2.3 Maintenance Data Versus Imposed Climatic Environment.

a. Maintenance analysis for each imposed environmental condition.

b. Tools and equipment performance versus each imposed environmental condition.

c. Maintenance literature package versus each imposed environmental condition.

d. Maintenance safety data as correlated to the imposed environmental condition.

e. Human factors as correlated to the imposed environmental condition.

f. Time study versus maintenance function as applicable for each imposed environmental condition.

6. DATA REDUCTION AND PRESENTATION.

6.1 Data Reduction. Data reduction in general involves the processing of raw data which consists of organizing, identifying, and correlating test data as to time, parameter grouping and test run. As required, test data measurement units will be converted and analysis performed to satisfy the test objective and verify compliance or noncompliance with the test criteria or specifications.

6.2 Data Presentation.

a. A composite documentation of the reduced and correlated data will be arranged normally by test phases in the general form of a narrative description supported by diagrams, graphs, photographs and tabular data, as required. It should be clearly evident, with supportive data, the degree to which the test item (aircraft, aircraft engine, armament or avionics) satisfies the test criteria or specifications under the imposed environmental conditions.

b. In the instance of a total or partial failure of the test item to perform its intended mission or function due to a simulated environmental condition, assess the broad implications of the failure to the developmental equipment itself and to the operational mission objective.

c. Summarize the test results and present any instance where the developmental test item fails to meet the test criteria or design objectives or might present safety or health hazards to users or cause system damage.

d. Provide, when possible, recommendations for solutions to any problems encountered.

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APPENDIX A

POST-TEST CHECKLIST

Climatic Chamber Testing

(Aircraft, Engine, Armament, and Avionics)

	YES	NO
1. Has developmental testing been completed in accordance with the appropriate TOP presented for each subtest presented in paragraph 3.2(a-i)?		
2. Were all test objectives presented in paragraph 3.2(a-i) addressed and, if not accomplished, adequately explained?		
3. Were the test facilities and other accommodations and support equipment sufficient to accomplish the test?		
4. Were the test results compromised in any way due to insufficient test preparation?		
5. Were the test results compromised in any way due to test control procedures?		
6. Were the test results compromised in any way due to performance test procedures?		
7. Were the test results compromised in any way due to data gathering, reduction or presentation techniques?		
8. Have all data collected been reviewed for correctness and completeness?		
9. Have performance data been collected, recorded and presented in accordance with this TOP 7-3-521?		

	YES	NO
10. *Have all data forms in Appendix B of all appropriate TOPs presented in paragraph 3.2(a-i) been completed and reviewed for inclusion into the final test report?*		

APPENDIX B

DATA COLLECTION FORM

CLIMATIC CHAMBER TESTING
(Aircraft, Engine, Armament, and Avionics)

I. Date:_____ Test Began--Time:_____ End Time:_____

II. Test Facility Identification:

III. Test Method:_____ Test Run:_____

IV. Test Item Identification:

Nomenclature	Model No.	Serial No.

V. Special Test Equipment:

Nomenclature	Model No.	Serial No.	Calibration		Accuracy
			Col Date	Exp Date	
1.					
2.					

VI. Test Personnel:

Name	Title	Test Function	Comments
1.			
2.			
3.			

VII. Test Item Installation and Facility Accommodations Assessment:

Assessment Personnel Name	Assessment			Comments
	Excellent	Good	Acceptable	

VIII. Test Chamber Atmospheric Environment Condition:

Parameter	Test Initiation	Test End Conditions
Temperature	_____	_____
Relative Humidity	_____	_____
Atmospheric Pressure	_____	_____
Precipitation	_____	_____
Wind	_____	_____

IX. Test Anomaly: _____Test Item_____Special Equipment_____Clim. Facility

1. Time:

2. Test Chamber Atmospheric Environmental Condition:

   a. Temperature

   b. Relative Humidity

   c. Atmospheric Pressure

   d. Precipitation

   e. Wind

3. Test Item Performance Parameters:

a. Temperatures _____ Data Source _____

b. Pressures _____ Data Source _____

c. Velocities (RPM) _____ Data Source _____

d. Torques _____ Data Source _____

e. Forces _____ Data Source _____

f. etc. _____ Data Source _____

4. Narrative Description Including:

a. Observer/narrator - name

b. Test event time line surrounding incident

c. Pertinent circumstances surrounding incident

d. Parameter changes surrounding incident

_____

_____

_____

_____

X. Maintenance Test Data:

1. Tools and Equipment Assessment vs Test Run:

Assessment Personnel Name _____

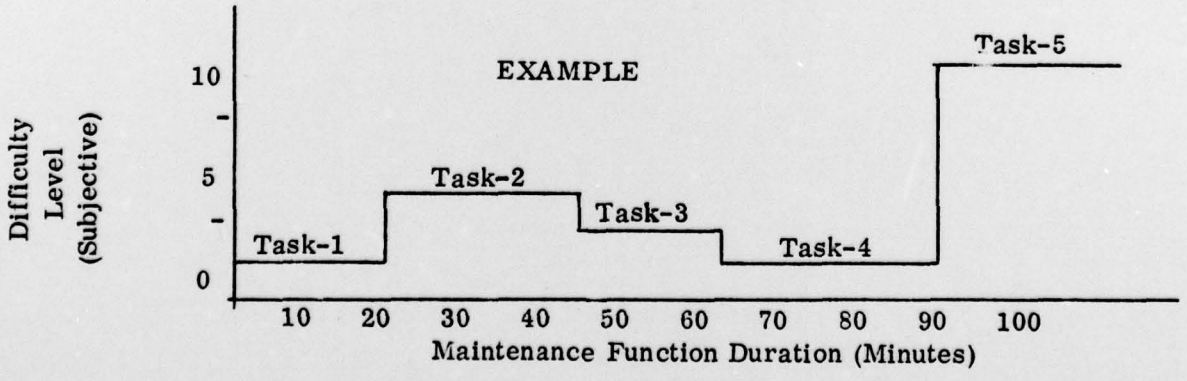
Nomenclature	Assessment				Comment
	Excel.	Good	Adeq.	Not Adeq.	
1.					
2.					
3.					
..					

2. Maintenance Literature Assessment vs Test Run:

Assessment Personnel Name_____

Nomenclature	Assessment				Comment
	Excel.	Good	Adeq.	Not Adeq.	
1.					
2.					
3.					
..					

3. Maintenance Time Study vs Test Run:



4. Maintenance Data vs Test Run:

Task No. / Time Minutes	Nomenclature	Difficulty Level 1-10	Personnel Req			Comment
			MOS / No. Req	MOS / No. Req	MOS / No. Req	

APPENDIX C
METHOD 501.1
HIGH TEMPERATURE

1. PURPOSE. The high temperature test is conducted to determine the resistance of equipment to elevated temperatures that may be encountered during service life either in storage (without protective packaging) or under service conditions.

1.1 General effects. In equipment, high temperature conditions may cause the permanent set of packings and gaskets. In items of complex construction, binding of parts may also result due to differential expansion of dissimilar materials. Rubber, plastic, and plywood may tend to discolor, crack, bulge, check, or craze. Closure and sealing strips may partially melt and adhere to contacting parts.

1.2 Procedure I is intended to approximate the exposure of equipment to a high temperature storage condition for a period of time prior to operation.

1.3 Procedure II is intended to approximate the cyclic high temperature stresses that equipment is exposed to during storage and operation.

2. APPARATUS. Temperature chamber.

3. PROCEDURES.

3.1 Procedure I

Step 1 - Prepare the test item in accordance with General Requirements, 3.2 (See C-8 this TOP).

Step 2 - Raise the internal chamber temperature to 71°C (160° F) or as specified in the equipment specification.

Step 3 - Maintain the internal chamber temperature for a period of 48 hours or as specified in the equipment specification while insuring the relative humidity is not in excess of 15 percent.

Step 4 - Adjust the internal chamber temperature to the highest operating temperature for which the test item is designed to operate and maintain until temperature stabilization of the test item is reached.

Step 5 - Operate the test item until the item is stabilized or as specified in the equipment specification, and obtain results in accordance with General Requirements, 3.2.4.

Step 6 - Return the test item, nonoperating to standard ambient condition and stabilize.

Step 7 - Operate and inspect test item and obtain results in accordance with General Requirements, 3.2.

NOTE: The rate of temperature change (steps 2, 4, and 6) may be the maximum attainable by the chamber, but shall not exceed 10°C (18° F) per minute.

3.2 Procedure II

Step 1 - Prepare the test item in accordance with General Requirements, 3.2.

Step 2 - Raise the internal chamber temperature to 49°C (120° F).

Step 3 - Maintain internal chamber temperature for 6 hours at 49°C (120° F).

Step 4 - Raise the internal chamber temperature to 71°C (160° F) within a time period of 1 hour and then maintain at that temperature for 4 additional hours.

Step 5 - Lower the internal chamber temperature to 49°C (120° F) within a time period of 1 hour.

Step 6 - Repeat steps 3, 4, and 5 two additional times (making a total of three 12-hour cycles).

Step 7 - Adjust the internal chamber temperature to the highest operating temperature under which the test item is designed to operate and maintain until temperature stabilization of the test item is reached.

Step 8 - Operate the test item until the item is stabilized or as specified in the equipment specification and obtain results in accordance with General Requirements, 3.2.

Step 9 - Return the test item, nonoperating, to standard ambient conditions and stabilize.

Step 10 - Operate and inspect the test item and obtain results in accordance with General Requirements, 3.2.

4. SUMMARY. The following details shall be as specified in the equipment specification:

a. Procedure number

b. Pretest data required

c. Failure criteria

d. Highest operating temperature at which the test item is designed to operate

e. Length of time required for operation and required measurements

f. Internal chamber temperature if other than 71°C (160° F)

g. Internal chamber temperature dwell time if other than 48 hours.

APPENDIX C
METHOD 502.1
LOW TEMPERATURE

1. PURPOSE. The low temperature test is conducted to determine the effects of low temperature on equipment during storage without protective packaging and service use.

1.1 General effects. Differential contraction of metal parts, loss of resiliency of packing and gaskets, and congealing of lubricants are a few of the difficulties associated with low temperature.

2. APPARATUS. Temperature chamber.

3. PROCEDURES.

3.1 Procedure I

Step 1 - Prepare the test item in accordance with General Requirements, 3.2. (See C-8, this TOP.)

Step 2 - Lower the internal chamber temperature to the storage temperature -57°C (-70° F) or as specified in the equipment specification and maintain for a period of 24 hours after stabilization or for the period specified in the equipment specification.

Step 3 - Inspect the test item in accordance with General Requirements, 3.2.

Step 4 - Adjust the internal chamber temperature to the lowest temperature under which the test item is designed to operate as specified in the equipment specification and maintain until temperature stabilization of the test item is reached.

Step 5 - Operate the test item until the item is stabilized or for the time specified in the equipment specification and obtain results in accordance with General Requirements, 3.2.

Step 6 - Return the test item, nonoperating, to standard ambient conditions and stabilize.

Step 7 - Operate and inspect the test item and obtain the results in accordance with General Requirements, 3.2.

NOTE: The rate of temperature change (steps 2, 4, and 6) may be the maximum attainable by the chamber but shall not exceed 10^{o}C (18^{o} F) per minute.

4. SUMMARY. The following details shall be as specified in the equipment specification:

a. Pretest data required

b. Failure criteria

c. Storage temperature and duration if different from step 2

d. Lowest operating temperature

e. Chamber air velocity, where the heat transfer rate from the surface of the test item is important

f. Length of time required for operation and required measurements.

APPENDIX C
METHOD 503.1
TEMPERATURE SHOCK

1. PURPOSE. The temperature shock test is conducted to determine the effects on equipment of sudden changes in temperature of the surrounding atmosphere.

1.1 General effects. Adverse effects could occur in service due to rapid altitude changes during shipments and airdrops.

2. APPARATUS. A high temperature chamber and a low temperature chamber.

3. PROCEDURE.

3.1 Procedure I

Step 1 - Prepare the test item in accordance with General Requirements 3.2 (see C-8, this TOP), and raise the internal chamber temperature to 71°C (160° F). Maintain for a period of not less than 4 hours or until the test item stabilizes.

Step 2 - At the conclusion of this time period, the test item shall be transferred, within 5 minutes, to a cold chamber with an internal chamber temperature of -57°C (-70° F).

Step 3 - The test item shall be exposed to this temperature for a period of not less than 4 hours or until the test item stabilizes.

Step 4 - At the conclusion of this time period, the test item shall, within 5 minutes be returned to the high temperature chamber maintained at 71°C (160° F).

Step 5 - The test item shall be exposed to this temperature for a period of not less than 4 hours or until the test item stabilizes.

Step 6 - Repeat steps 2 through 5.

Step 7 - Repeat steps 2 and 3.

Step 8 - Return the test item to standard ambient conditions and stabilize.

Step 9 - Operate and inspect the test item and obtain results in accordance with General Requirements, 3.2.4.

NOTE: For step 2 and step 4, when authorized by the procuring activity, large or heavy test items shall be transferred from one chamber to the other in the minimum practical times.

4. SUMMARY. The following details shall be specified in the equipment specification:

a. Pretest data required.

b. Failure criteria.

3.1.4 Stabilization of test temperature

3.1.4.1 Operating. Unless otherwise specified, temperature stabilization will have been attained when the temperature of the part of the test item considered to have the longest thermal lag is changing no more than 2.0°C (3.6° F) per hour. Exceptions may occur on large test items.

3.1.4.2 Nonoperating. Unless otherwise specified, temperature stabilization will have been attained when the temperature of the part of the test item considered to have the longest thermal lag reaches a temperature within 2.0°C (3.6° F) of the prescribed temperature, except that any critical component (e.g., battery electrolyte for engine starting test) will be within 1°C (1.8° F). Exceptions may occur on large test items. When changing temperatures, the temperature of the chamber air may be adjusted up to 5°C (9° F) beyond the desired end point for a period of time of up to 1 hour to reduce stabilization time, provided that the stabilization requirements of this paragraph are ultimately attained relative to the specified end point temperature, and provided the extended chamber temperatures will not cause damage to the test item.

3.2 Performance of test.

3.2.1 Pretest performance record. Prior to proceeding with any of the environmental tests, the test item shall be operated under standard ambient conditions (see 3.1) to obtain data for determining satisfactory operation of the item as specified in the equipment specification, before, during and after the environmental test, as applicable. A record of specific pretest data shall be made to determine that the test item performs within prime item specification requirements. The pretest record shall also include the following, as applicable:

a. The functional parameters to be monitored during and after the test, if not specified in the equipment specification. This shall include acceptable functional limits (with permissible degradation) when operation of the test item is required.

3.2.2 Installation of test item in test facility. Unless otherwise specified, the test item shall be installed in the test facility in a manner that will simulate service usage, making connections and attaching instrumentation as necessary.

Plugs, covers, and inspection plates not used in operation, but used in servicing shall remain in place. When mechanical or electrical connections are not used, the connections normally protected in service shall be adequately covered. For tests where temperature values are controlled, the test chamber shall be at standard ambient conditions when the test item is installed. The test item shall then be operated to determine that no malfunction or damage was caused due to faulty installation or handling. The requirement for operation following installation of the test item in the test facility is applicable only when operation is required during exposure to the specified test.

3.2.3 Performance check during test. When operation of the test item is required during the test exposure, suitable tests shall be performed to determine whether the test exposure is producing changes in performance when compared with pretest data.

3.2.4 Post-test data. At the completion of each environmental test, the test item shall be inspected in accordance with the equipment specification and the results shall be compared with the pretest data obtained in accordance with 3.2.1.

3.2.5 Test data. Test data shall include complete identification of all test equipment and accessories. The data shall include the actual test sequence used and ambient test conditions recorded periodically during the test period. The test record shall contain a signature and data block for certification of the test data by the test engineer.

3.2.6 Failure criteria.

a. The item shall have failed the test when any of the following occur:

(1) Monitored functional parameters deviate beyond acceptable limits established in 3.2.1.a.

(2) Catastrophic or structural failure.

(3) Mechanical binding or loose parts, including screws, clamps, bolts, and nuts, that clearly result in component failure or a hazard to personnel safety.

(4) Malfunction.

(5) Degradation of performance beyond pretest record or equipment specification requirements established in 3.2.1 (record to be made after test).

NOTE: Certain types of equipment (e.g., propellants and electrically driven devices) are often expected to demonstrate lesser performance at an environmental extreme, particularly low temperature. A failure would occur only if degradation is more than expected.

(6) Any additional deviations from acceptable criteria established before the test and recorded according to 3.2.1.

(7) Deterioration, corrosion, or change in tolerance limits of any internal or external parts which could in any manner prevent the test item from meeting operational service or maintenance requirements.

b. Any additional or different failure criteria shall be as specified in the equipment specification.

3.3 Test facilities and apparatus. Test facilities, chambers, and apparatus used in conducting the tests contained in this standard shall be capable of meeting the conditions required.

3.3.1 Test chamber.

3.3.1.1 Volume of test chamber. The volume of the test chamber shall be such that the bulk of the item under test will not interfere with the generation and maintenance of the test conditions. When testing multiple sample items simultaneously, the test chamber shall be of sufficient size so that each test unit is provided uniform environmental conditions and is not subjected to nontest environments.

3.3.1.2 Heat source. The heat source of the test facility shall be so located that radiant heat from the source will not fall directly on the test item, except where application of radiant heat is one of the test conditions.

3.3.1.3 Location of temperature sensors. Unless otherwise specified, thermocouples or equivalent temperature sensors utilized to determine or control the specified chamber temperature shall be located centrally within the chamber, in the supply airstream, or in the return airstream whichever provides the specified test conditions at the bulk under test and shall be baffled or otherwise protected against radiation effects.

3.3.1.4 Internal air circulation. The conditioned air flow shall be suitably baffled to provide uniform air flow around the test item. If multiple test items are tested, they shall be so spaced as to provide free circulation between the test items and the chamber walls.

3.4 Test data. Test data shall include complete identification of all test equipment and accessories. The data shall include the actual test sequence used and ambient test conditions recorded periodically during the test period. The test record shall contain a signature and date block for certification of the test data by the test engineer.

4. TEST SEQUENCE.

4.1 See table I for recommended test sequence.